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3. STATUS REPORT ON "STUDIES ON THE RADIOACTIVE DATING OF THE LUNAR SURFACE"

by

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I. General

27884 The experimental studies on a system for the determination of rare gas isotope concentrations by remote-controlled operation, which were described in the status reports I and II, were continued. Modifications in the rare gas and purification system resulted in smaller dimensions, reduced weight and greater reliability. The experiments with the extraction system for four rock-samples and the development of valves where continued.

In addition to the experimental and technical work, a theoretical study on the possibilities, significance and limitations of dating lunar surface material is carried out. A separate report on these studies will be presented and we expect it to be ready at the end of May 1964. It will contain detailed analyses of the possible significances of argon/potassium-, helium/uranium- and xenon-ages and radiation-ages with respect to different theories and hypotheses on the history of the moon and the history of cosmic radiation. author

II. Further development of the extraction and purification system for rare gases from one sample.

a.) The original system developed and described in status report II uses two radiation shields. The inner shield supports also the graphite crucible for the thermite mixture. Theoretical calculations have shown, that the outer radiation shield has little influence on the peak temperature reached by the system. The outer radiation shield approaches equilibrium temperature only after about 3 minutes, when the temperature of the crucible has already dropped to below 1200°C. Experimental tests showed that the maximum temperature reached by the molybdenum crucible was indeed the same within 25°C with and without the outer radiation shield. Also the initial cooling rate is very nearly the same and only after about 2 minutes does the outer radiation shield slow down the cooling by about 20%. The extraction performance of the system is determined by the maximum temperature reached and by the time interval the system is at high temperatures (above approximately 1200 $^{\circ}$C). Thus the second radiation shield can be omitted without changing the performance of the system, resulting in a reduction of the diameter of the outer can.

b.) The original thermite mixture used had a fairly low density (1.3g cm^{-3}). All the initial experiments and also the system described in status report II were made with this mixture. In the meantime we were able to obtain a thermite mixture with about twice the density of the one originally used*. Tests showed that this new mixture was also performing satisfactorily in our application. It was thus possible to reduce the diameter of the graphite crucible by about 20% for the same total amount of thermite mixture (100gm).

c.) In the system described in status report II the maximum grain size of the sample is limited by the 4mm diameter of the sample introduction system. Therefore, a rather finely crushed sample is needed to prevent any clogging during the sample introduction. A new molybdenum crucible was designed which has a minimum clearance of 7mm. The outer diameter of the crucible was raised from 14mm to 16mm and the insert which holds the titanium sponge in place is now machined in one piece. A 7 mm internal diameter of the sample introduction tube could thus be obtained. Figure 1 shows a cross-section through the new system. The overall diameter has been reduced from 81mm to 67mm. The length has not been changed and the system ready to operate weighs 470g. Extraction tests have been successfully performed with this new system. A certain reduction of the diameter and length by reducing the clearance between the graphite crucible and the outer can still seems possible.

d.) All the electrical fuses tested so far for the ignition of the thermite mixture do not work in vacuum. Also specially developed fuses (squib S 239AO, Hercules Powder Company, Wilmington, Del.) failed. A certain minimum

*supplier: Fa. H. Hamberger A.G., Oberried, BE, Switzerland.

gas pressure is required for satisfactory operation (about 15 to 20 cm Hg). When the system is heated up during the extraction, this gas together with some gases given off by the graphite crucible and the reacting thermite mixture reach a considerable pressure, demanding relatively thick walls for the outer can. A considerable improvement was obtained by placing about 5gms of magnesium metal in the graphite crucible and using oxygen as gas. After the ignition the oxygen reacts with the magnesium, thus reducing the gas pressure.

III. Studies on the gas purification process.

In our last report we have shown that the gases which evolve from the molten rock sample are purified by means of hot titanium, which is placed inside the double-wall molybdenum crucible. Both, the melting of the sample and the heating of the titanium is achieved with the same energy source, the thermite mixture. This method efficiently removes N_2, O_2, H_2O and CO_2. However, the removal of hydrocarbons by titanium alone is not complete. We have tested a number of reagents and a molecular sieve in order to improve this. So far the best results were obtained with a CuO-Pd-mixture at a temperature of more than 800°C. This mixture efficiently cracks and oxidizes the lighter hydrocarbons. The CO_2 and H_2O formed are removed by hot titanium. Figure 2 shows the mass-spectra of a rare gas sample extracted from the meteorite Pultusk without and with additional cleaning by CuO-Pd. The peaks due to hydrocarbons (masses 43, 42, 41, 39, 30, 29, 27, 26, 16) are reduced by a factor of about 50. The interference from hydrocarbons at the mass positions 36 and 38 (the two rare argon isotopes) after the additional cleaning is less than 3 percent and 25 percent respectively. The work on the hydrocarbon removal is beeing continued.

IV. Extraction and purification system for rare gases from four samples.

The preliminary experiments for the determination of the amount of thermite mixture necessary for this type of system and the best geometrical arrangement have been concluded. A special high vacuum apparatus has been constructed for degasing of the parts of this system and for the necessary vacuum gold soldering. Four sample extraction systems are beeing built now and there yield of extraction and there purification efficiency will be tested.

V. Valves and associated equipment.

A model of a 4 sample introduction valve has been built and vacuum tested. It is opened and closed by a 100 degree rotation of an operating lever. In the open position the valve has a straight-through clearance of 8 mm. Thus a 1/4" solid drill core could be introduced into the new extraction system using such a sample introduction valve. In the closed position the leak-rate is less than 10^{-8} cc STP/sec, using viton gaskets.

Figure 3 shows a cross-section through this valve and figure 4 is a picture of the experimental model. The operating principle is the following: In the open position the four holes in the base plate and in the closing plate are in line. By turning the operating lever the closing cam ring turns, and by means of the latch assembly also the closing plate and the fixed cam ring are turned. A stop prevents the closing plate from turning more than 45 degrees. The holes in the base plate are then covered by the closing plate. When the closing cam ring is turned further, the ball bearing balls are pressed out of their conical seats and the main spring is compressed, thus pressing the closing plate against the viton gaskets in the base plate and giving a vacuum tight seal.

The simplicity of the operating movement should make it possible to operate the valve with powder driven bellows actuators. We are studying at the present such an operating mechanism.

We would like to thank Irène Merk for her contributions to many of the experiments mentioned in this and the previous report. Furthermore, R. Hausmann, H. Schenk and M. Grögler have worked on this project and we would like to acknowledge their help.

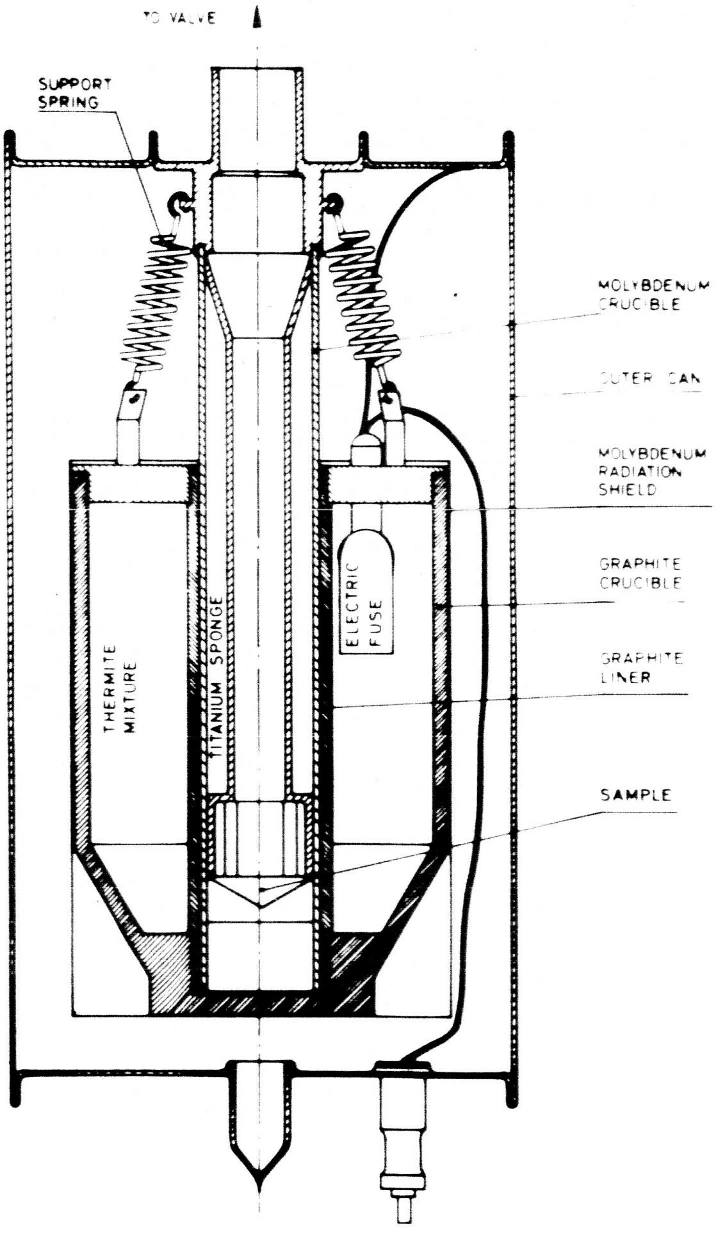

FIG. 1: ONE SAMPLE EXTRACTION AND PURIFICATION SYSTEM.
NEW SMALLER MODEL (TYPE 63)
FULL SCALE

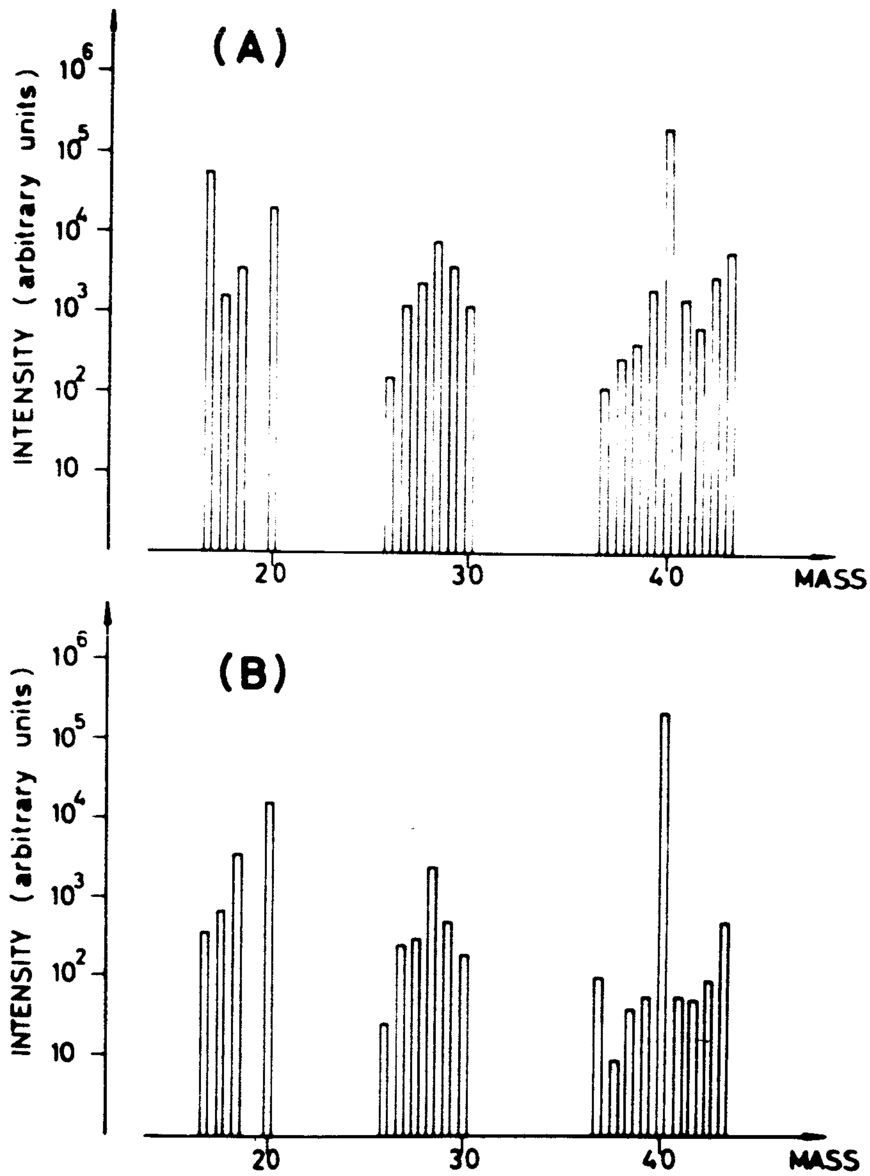

FIGURE 2: Mass spectra of gas samples extracted from 0.5g of Pultusk meteorite. (logarithmic representation)

(A) No additional purification applied.

(B) Additional purification with hot CuO-Pd mixture.

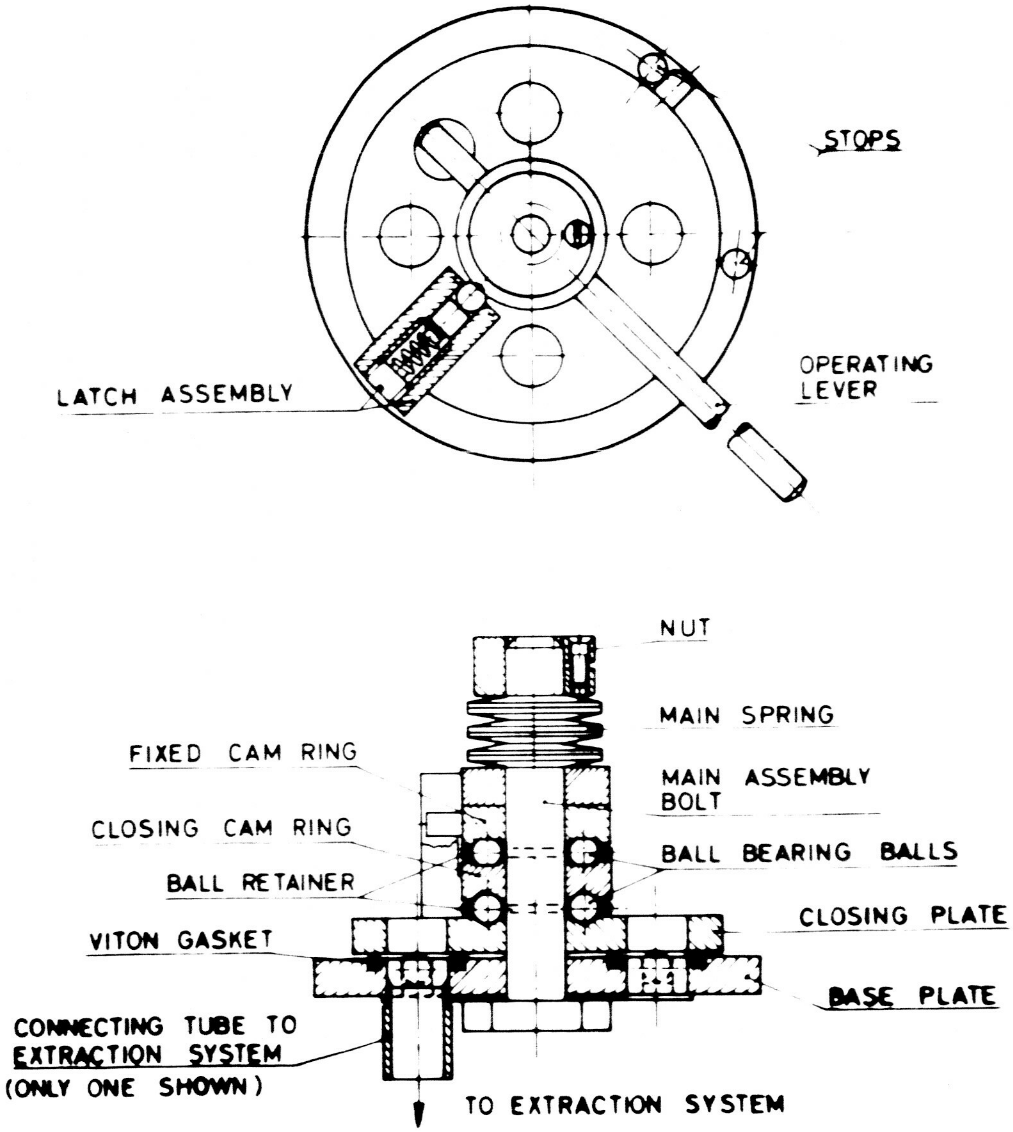

FIGURE 3 : 4 SAMPLE INTRODUCTION VALVE (OPEN POSITION SHOWN)
FULL SCALE

Figure 4: Four sample introduction valve. Experimental model.